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MAINTENANCE AND MODERNISATION: DEFINITION AND FINANCIAL CONSEQUENCES

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ABSTRACT

Maintenance and modernisation serve different goals.

Maintenance serves a static goal, formulated in the past at the moment of new construction or modernisation. A constant level of housing services will be maintained. On the basis of the life span and maintenance activities, the optimum in terms of minimised cost will be chosen. As a consequence the maintenance expenditures become predictable over the life span of the component concerned.

Modernisation serves a dynamic goal, formulated in the future at the moment of adaptation of the building. The level of services desired changes over time, which usually will result in non-identical replacement of building components. The moment of adaptation may be foreseeable, but not the new level of needs and the related expenditures. A new range of maintenance activities will be planned.

As a consequence of unforeseeable adaptation expenditures, life cycle costing over the total life of a building cannot exist. LCC needs information about all expenditures over the life of the building; this is not possible and not useful.

Decision making, based on cost, needs a cost unit linked to the product demanded for: square meters during a year. So, expenditures have to be translated into annual cost of housing services.

Maintenance expenditures will be spread equally over the economical life of the component concerned. Investment expenditures (new construction or modernisation) as well have to be translated into cost over the economical life of the component assembled; i.e. just depreciation.
Two points are important now:
- changes in the construction prices;
- shape and period of depreciation.

About the price level we just state that all cost prices should be on the level of the construction cost at the moment of supplying the housing services to the market. Only because of political reasons or speculations of the investors another basis may be chosen, but in those cases cost price calculation is not the main goal.

The second point is of special concern for us, because - as we will see - maintenance and modernisation are closely connected with the problem of depreciation. Only buildings - and to some extent planes and ships as well - will be modernised once or several times during their lifes. Machines just will be maintained and be replaced totally after depreciation.

**KEEPING BUILDINGS USABLE**

Buildings have to be kept usable at minimised cost, by maintenance and modernisation because of changing demand.

In the short run demand is of constant quality and well defined in the program of requirements. An equilibrium has to be found between expenditures for assembling components and for maintenance.

This may be considered as a static goal (fig.1): generate housing services of constant quantity and quality at minimised cost. The cost of maintenance activities are - as an average over the life span of the component - a constant annual amount of money.

![Diagram](image)

**fig 1.** Predictable and not-predictable activities to keep buildings usable
In the long run demand will change, which results in an adapted program of requirements and a need for modernisation. The components concerned will be replaced non-identically or will not be replaced at all; components with a totally different type of services may be added to the building.

New components need an (extra) investment, without any connection to the past. This should be the same in case of replacement: the component to be replaced should have been earned back out of housing services sold in the past. The replacing component is just a new investment.

The difference between maintenance and adaptation can be described by stating, that maintenance activities can and have to be planned within the life span of a component, while adaptation activities depend on the changing demand at the end of the life span of the component. As soon as non-identical replacement is an alternative, the expenditure concerns a new investment and not maintenance.

FINANCIAL CONSEQUENCES

Modernisation of a building means, that part of the building will remain unchanged, while some components will be replaced non-identically. As a consequence we have to face various lifes of components.

Investment expenditures and maintenance expenditures are connected to components with differing life span: support structure, shell components, inside walls, mechanical equipment, electrical equipment. The problem now is to find a clear picture of the cost of housing services within a rental period.

The starting point for cost calculation is, that a component supplies services at a constant level of quality over its usable life span. When demand for these services remains unchanged (usable life span in fact equals economical life span) it is obvious that the cost price should be constant as well.

Investment, demolishing and maintenance expenditures have to be allocated to the services supplied over the usable period. The service is the use of a component or a combination of components during a year.

Using the annuity calculation, all expenditures during the life span of the component will be recalculated, resulting in a constant amount of money each year, enough to cover all expenditures (fig.2). Cost of a component is composed of capital cost (depreciation and interest cost) based on the investment expenditure and maintenance cost calculated on the basis of maintenance expenditures. Demolishing expenditures to make replacement possible have to be allocated to the component to be demolished; they are part of the investment.
The rental contract between user and owner concerns all housing services rented during the contract period.
Annual cost of components with differing life span have to be added, which is no problem since the calculated cost is on an annual basis for all components. A yearly rent is a composition of sub-rents concerning various components (fig.3). After modernisation - point A - the new rent is composed out of the sub-rent of the non-replaced components (e.g. support, shell) and the newly assembled infill components. The rent after point A can only be calculated as soon as the program of requirements for period A-B is available. The new rent can be lower or higher than the former rent.

**fig.3. Annual cost by addition.**
OPTIMAL MAINTENANCE

Each building component has to be considered as a separate durable production good, which - of course only in combination with other components - may supply usable housing services. However, the optimisation of the annual cost to a large extent is an isolated problem.

Maintenance activities and expenditures have to be planned in such a way, that the total of expenditures over the life span of a component (initial investment and demolishing included) result in minimised annual cost.

Two points are important to realise minimised cost:
- the discrepancy between technical and economical life span;
- the influence of maintenance on the life span.

Usually the technical life span of a component is longer than the economical life span. But the initial expenditure and maintenance expenditures have to be paid back out of income during the economical life span. Or put differently: all expenditures have to be allocated to the years within the economical life span.

By using other materials the technical life span may be shortened, but materials to ensure stability and insulation will result in a rather long technical life span.

Maintenance is more efficient to influence the technical life. As illustrated in figure 4, annual maintenance cost has to be balanced with depreciation (and interest) cost.

![Graph showing annual cost, capital cost, and total cost over three depreciation periods.](image)

fig.4. Balancing capital cost and maintenance cost over three depreciation periods.
When the economical life span is shorter than the optimal technical life span, depreciation has to be based on the shorter period, which results in an increase of the annual cost. Shortening the technical life span by reducing the average maintenance expenditures is only efficient when the increase of depreciation cost is less. One may try to reduce the maintenance cost, as long as the component can still deliver the services demanded for.

In the case that the technical life span is shorter than the desired economical life span, identical replacement is the best decision.

CONCLUSION

Cost calculation needs a good definition of maintenance and of modernisation, since maintenance is foreseeable, while the level of adaptation is not. Maintenance expenditures have to be balanced with the investment expenditure over the economical life of the component concerned. The investment has to be depreciated over the same life span. In financial sense new investment is the same as modernisation. Demolishing expenditures are part of the investment of the component to be replaced.

Consequence of the distinction between maintenance and modernisation is, that a variety of life spans of components has to be recognised. Each component has its own annual cost price. Addition of these prices for a year generates the rental price.

Since not all expenditures over the life of a building can be foreseen, life cycle costing is utopia.